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Suppression of the Richtmyer-Meshkov instability in the presence of a magnetic field

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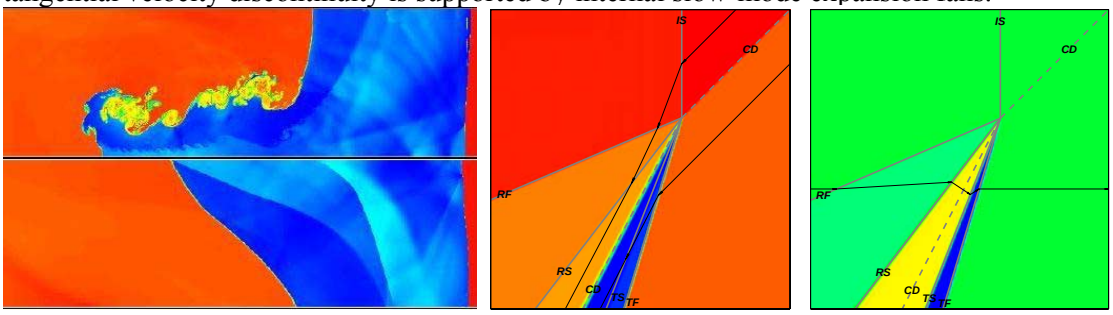
We present numerical evidence that the Richtmyer-Meshkov (RM) instability of an interface separating conducting fluids of different densities may be suppressed in the presence of a magnetic field. An example of this is shown in Figure 1(a) (Samtaney 2003). An explanation for this phenomena can be developed by considering the problem of regular refraction of a shock at an oblique, planar contact discontinuity. We show that in the presence of a magnetic field, the shock refraction process produces a system of from five to seven plane waves that may include MHD shocks, compound waves, 180° rotational discontinuities, and expansion fans that intersect at a point. In these solutions, the shocked contact is vorticity free and hence Kelvin-Helmholtz stable. The set of equations governing the structure of these multiple-wave solutions are obtained in which fluid property variation is allowed only in the azimuthal direction about the wave-intersection point. A numerical method of solution is described and examples are compared to the results of numerical simulations, as shown in Figure 1(b)-(c). Solutions in the limit of vanishingly small magnetic field are examined. These correspond to the hydrodynamic triple-point with the shocked contact replaced by a singular wedge whose angle scales with the applied field strength. Within the singular wedge the magnetic field strength is finite, the MHD contact remains vorticity free, and the tangential velocity discontinuity is supported by internal slow-mode expansion fans.



(a) (b) (c)

Figure 1: (a) Density fields from RM simulations with (bottom) and without (top) a magnetic field present. (b) Density contours, and (c) vertical magnetic field contours from simulations compared to computed shock angles. Sample streamlines and field lines are shown in (b) and (c) respectively.

References

Samtaney, R. 2003 Suppression of the Richtmyer-Meshkov instability in the presence of a magnetic field; *Phys. Fluids* **15**(8), 53-56.